INTERNATIONAL STANDARD

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Second edition
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Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels — Classification

Produits consommables pour le soudage — Fils-électrodes, fils, baguettes et dépôts pour le soudage à l'arc sous flux gazeux des aciers à haute résistance — Classification

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16834 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This second edition cancels and replaces the first edition (ISO 16834:2006), which has been technically revised.

The main changes compared to the previous edition are:

a) in 4.4, the separation between the A and B side has been eliminated;

b) in Table 3B, the chemical composition has been changed for 4M31 and N5M3;

c) footnote a to Table 3B has been redrafted to give more precision;

d) the designation examples in Clause 10 have been modified.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Introduction

This International Standard recognizes that there are two somewhat different approaches in the global market to classifying a given wire electrode, wire, rod or deposit, and allows for either or both to be used to suit a particular market need. Application of either type of classification designation (or of both where suitable) identifies a product as classified in accordance with this International Standard. The classification in accordance with system A is mainly based on EN 12534:1999[1]. The classification in accordance with system B is mainly based upon standards used around the Pacific Rim. Future revisions will aim to merge the two systems into a single classification system.

This International Standard provides a classification for the designation of wire electrodes, wires, rods and deposits in terms of their chemical composition and, where required, in terms of the yield strength, tensile strength and elongation of the all-weld metal. The ratio of yield to tensile strength of weld metal is generally higher than that of the parent metal. Users should note that matching weld metal yield strength to parent metal yield strength does not necessarily ensure that the weld metal tensile strength matches that of the parent material. Thus, where the application requires matching tensile strength, selection of the consumable should be made by reference to column 3 of Table 1A or 1B, as appropriate.

Welding consumables — Wire electrodes, wires, rods and deposits for gas shielded arc welding of high strength steels — Classification

1 Scope

This International Standard specifies requirements for classification of wire electrodes, wires, rods and all-weld metal deposits in the as-welded condition and in the post-weld heat-treated (PWHT) condition for gas shielded metal arc welding and tungsten inert-gas welding of high-strength steels with a minimum yield strength greater than 500 MPa, or a minimum tensile strength greater than 570 MPa. One wire electrode can be tested and classified with different shielding gases.

This International Standard is a combined specification providing for classification utilizing a system based upon the yield strength and the average impact energy of 47 J of all-weld metal, or utilizing a system based upon the tensile strength and the average impact energy of 27 J of all-weld metal.

e) Clauses, subclauses and tables which carry the suffix letter "A" are applicable only to wire electrodes, wires, rods and deposits classified according to the system based upon the yield strength and the average impact energy of 47 J of all-weld metal under this International Standard.

f) Clauses, subclauses and tables which carry the suffix letter "B" are applicable only to wire electrodes, wires, rods and deposits classified according to the system based upon the tensile strength and the average impact energy of 27 J of all-weld metal under this International Standard.

g) Clauses, subclauses and tables which do not have either the suffix letter "A" or the suffix letter "B" are applicable to all wire electrodes, wires, rods and deposits classified under this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

ISO 13916, *Welding — Guidance on the measurement of preheating temperature, interpass temperature and preheat maintenance temperature*

ISO 14175:2008, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

ISO 15792-1:2000, *Welding consumables — Test methods — Part 1: Test methods for all-weld metal test specimens in steel, nickel and nickel alloys*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

3 Classification

Classification designations are based upon two approaches to indicate the tensile properties and the impact properties of the all-weld metal obtained with a given wire electrode, wire or rod. The two designation approaches include additional designators for some other classification requirements, but not all, as is clear from the following clauses. In most cases, a given commercial product can be classified according to the classification requirements in both systems. Then either or both classification designations can be used for the product.

A wire electrode, wire or rod shall be classified in accordance with its chemical composition in Table 3A or Table 3B. A weld deposit shall be classified with additional symbols in accordance with the mechanical properties of its all-weld metal, using a shielding gas from a specific group.

3A Classification by yield strength and 47 J impact energy

The classification is divided into six parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the strength and elongation of all-weld metal (see Table 1A);

3) the third part gives a symbol indicating the impact properties of all-weld metal (see Table 2);

4) the fourth part gives a symbol indicating the shielding gas used (see 4.4);

5) the fifth part gives a symbol indicating the chemical composition of the wire electrode, wire or rod used (see Table 3A);

6) the sixth part gives a symbol indicating the post-weld heat treatment in case this is applied (see 4.6A).

3B Classification by tensile strength and 27 J impact energy

The classification is divided into five parts:

1) the first part gives a symbol indicating the product/process to be identified;

2) the second part gives a symbol indicating the strength and elongation of the all-weld metal in either the as-welded or post-weld heat-treated condition (see Table 1B);

3) the third part gives a symbol indicating the impact properties of all-weld metal in the same condition as specified for the tensile strength (see Table 2). The letter “U” after this designator indicates that the deposit meets an average optional requirement of 47 J at the designated Charpy test temperature;

4) the fourth part gives a symbol indicating the shielding gas used (see 4.4);

5) the fifth part gives a symbol indicating the chemical composition of the wire electrode, wire or rod used (see Table 3B).

4 Symbols and requirements

4.1 Symbol for the product/process

The symbol for the wire electrode, wire or rod used in the arc welding process shall be the letter G (gas shielded metal arc welding) and/or W (gas shielded arc welding with non-consumable tungsten electrode).

4.2 Symbol for strength and elongation properties of all-weld metal

4.2A Classification by yield strength and 47 J impact energy

The symbol in Table 1A indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition determined in accordance with Clause 5.

4.2B Classification by tensile strength and 27 J impact energy

The symbol in Table 1B indicates yield strength, tensile strength and elongation of the all-weld metal in the as-welded condition or in the post-weld heat-treated condition determined in accordance with Clause 5.

Table 1A — Symbol for tensile properties of all-weld metal
(Classification by yield strength and 47 J impact energy)

Symbol	Minimum yield strength[a] MPa	Tensile strength MPa	Minimum elongation[b] %
55	550	640 to 820	18
62	620	700 to 890	18
69	690	770 to 940	17
79	790	880 to 1 080	16
89	890	940 to 1 180	15

[a] For yield strength, the lower yield strength, R_{eL}, is used when yielding occurs, otherwise the 0,2% proof strength, $R_{p0,2}$, is used.

[b] Gauge length is equal to five times the test specimen diameter.

Table 1B — Symbol for tensile properties of all-weld metal
(Classification by tensile strength and 27 J impact energy)

Symbol[a]	Minimum yield strength[b] MPa	Tensile strength MPa	Minimum elongation[c] %
59X	490	590 to 790	16
62X	530	620 to 820	15
69X	600	690 to 890	14
76X	680	760 to 960	13
78X	680	780 to 980	13
83X	745	830 to 1 030	12

[a] X is “A”, “P” or “AP”; see 4.6B.

[b] For yield strength, the lower yield, R_{eL}, is used when yielding occurs; otherwise, the 0,2 % proof strength, $R_{p0,2}$, is used.

[c] Gauge length is equal to five times the test specimen diameter.

NOTE Post-weld heat treatment can alter the strength of the weld metal from that obtained in the as-welded condition.

4.3 Symbol for impact properties of all-weld metal

4.3A Classification by yield strength and 47 J impact energy

The symbol in Table 2 indicates the temperature at which an impact energy of 47 J is achieved under the conditions given in Clause 5A. Three test specimens shall be tested. Only one individual value may be lower than 47 J but not lower than 32 J.

4.3B Classification by tensile strength and 27 J impact energy

The symbol in Table 2 indicates the temperature at which an impact energy of 27 J is achieved in the as-welded condition or in the post-weld heat-treated condition under the conditions given in Clause 5B.

Five test specimens shall be tested. The lowest and highest values obtained shall be disregarded. Two of the three remaining values shall be greater than the specified 27 J level, one of the three may be lower but shall not be less than 20 J. The average of the three remaining values shall be at least 27 J.

The addition of the optional symbol U, immediately after the symbol for condition of heat treatment, indicates that the supplemental requirement of 47 J impact energy at the normal 27 J impact test temperature has also been satisfied. For the 47 J impact requirement, the number of specimens tested and values obtained shall meet the requirement of 4.3A.

When an all-weld metal or a welded joint has been classified for a certain temperature, it automatically covers any higher temperature in Table 2.

Table 2 — Symbol for impact properties of all-weld metal or welded joint

Symbol	Temperature for minimum average impact energy of 47 J[a,b] or 27 J[b] °C
Z	No requirements
A[a] or Y[b]	+ 20
0	0
2	−20
3	−30
4	−40
5	−50
6	−60

[a] See 4.3A.

[b] See 4.3B.

4.4 Symbol for shielding gas

The symbols for shielding gases shall be in accordance with ISO 14175:2008, for example:

— The symbol I1 shall be used when the classification has been performed with shielding gas ISO 14175-I1, 100% argon;

— The symbol M12, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M12, but without helium;

— The symbol M13 shall be used when the classification has been performed with shielding gas ISO 14175-M13;

— The symbol M20, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M20, but without helium;

— The symbol M21, for mixed gases, shall be used when the classification has been performed with shielding gas ISO 14175-M21, but without helium;

— The symbol C1 shall be used when the classification has been performed with shielding gas ISO 14175-C1, carbon dioxide;

— The symbol Z is used for an unspecified shielding gas.

4.5 Symbol for the chemical composition of wire electrodes, wires and rods

The symbols in Table 3A or Table 3B indicate the chemical composition of the wire electrode, wire or rod and includes an indication of characteristic alloying elements.

4.6 Symbol for condition of post-weld heat treatment

4.6A Classification by yield strength and 47 J impact energy

The symbol T indicates that strength, elongation and impact properties in the classification of all-weld metal are obtained after a post-weld heat treatment. The post-weld heat-treated condition shall be as specified in 5.3A.

4.6B Classification by tensile strength and 27 J impact energy

The symbol A shall be added to the classification of the weld deposits classified in the as-welded condition. The symbol P shall be added to the classification for weld deposits classified in the post-weld heat-treated condition. Both symbols AP shall be added to the classification for weld deposits classified in both conditions.

Table 3A — Symbol for chemical composition
(Classification by yield strength and 47 J impact energy)

Symbol (ISO 16834-A)	Chemical composition, % (by mass)[a,b]									
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	V	Total other elements
Mn3NiCrMo	0,14	0,60 to 0,80	1,30 to 1,80	0,015	0,018	0,50 to 0,65	0,40 to 0,65	0,15 to 0,30	0,30	0,03	0,25
Mn3Ni1CrMo	0,12	0,40 to 0,70	1,30 to 1,80	0,015	0,018	1,20 to 1,60	0,20 to 0,40	0,20 to 0,30	0,35	0,05 to 0,13	0,25
Mn3Ni1Mo	0,12	0,40 to 0,80	1,30 to 1,90	0,015	0,018	0,80 to 1,30	0,15	0,25 to 0,65	0,30	0,03	0,25
Mn3Ni1,5Mo	0,08	0,20 to 0,60	1,30 to 1,80	0,015	0,018	1,40 to 2,10	0,15	0,25 to 0,55	0,30	0,03	0,25
Mn3Ni1Cu	0,12	0,20 to 0,60	1,20 to 1,80	0,015	0,018	0,80 to 1,25	0,15	0,20	0,30 to 0,65	0,03	0,25
Mn3Ni1MoCu	0,12	0,20 to 0,60	1,20 to 1,80	0,015	0,018	0,80 to 1,25	0,15	0,20 to 0,55	0,30 to 0,65	0,03	0,25
Mn3Ni2,5CrMo	0,12	0,40 to 0,70	1,30 to 1,80	0,015	0,018	2,30 to 2,80	0,20 to 0,60	0,30 to 0,65	0,30	0,03	0,25
Mn4Ni1Mo	0,12	0,50 to 0,80	1,60 to 2,10	0,015	0,018	0,80 to 1,25	0,15	0,20 to 0,55	0,30	0,03	0,25
Mn4Ni2Mo	0,12	0,25 to 0,60	1,60 to 2,10	0,015	0,018	2,00 to 2,60	0,15	0,30 to 0,65	0,30	0,03	0,25
Mn4Ni1,5CrMo	0,12	0,50 to 0,80	1,60 to 2,10	0,015	0,018	1,30 to 1,90	0,15 to 0,40	0,30 to 0,65	0,30	0,03	0,25
Mn4Ni2CrMo	0,12	0,60 to 0,90	1,60 to 2,10	0,015	0,018	1,80 to 2,30	0,20 to 0,45	0,45 to 0,70	0,30	0,03	0,25
Mn4Ni2,5CrMo	0,13	0,50 to 0,80	1,60 to 2,10	0,015	0,018	2,30 to 2,80	0,20 to 0,60	0,30 to 0,65	0,30	0,03	0,25
Z[c]	Any other agreed composition										

[a] If not specified: Ti ≤ 0,10 % (by mass), Zr ≤ 0,10 % (by mass) and Al ≤ 0,12 % (by mass). The residual copper content in the steel including any coating shall comply with the stated value.

[b] Single values are maximum values.

[c] Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same Z classification are not interchangeable.

Table 3B — Symbol for chemical composition
(Classification by tensile strength and 27 J impact energy)

Symbol (ISO 16834-B)	Chemical composition % (by mass)[a,b]									
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Ti
2M3	0,12	0,30 to 0,70	0,60 to 1,40	0,025	0,025	—	—	0,40 to 0,65	0,50	—
3M1	0,05 to 0,15	0,40 to 1,00	1,40 to 2,10	0,025	0,025	—	—	0,10 to 0,45	0,50	—
3M1T	0,12	0,40 to 1,00	1,40 to 2,10	0,025	0,025	—	—	0,10 to 0,45	0,50	0,02 to 0,30
3M3	0,12	0,60 to 0,90	1,10 to 1,60	0,025	0,025	—	—	0,40 to 0,65	0,50	—
3M31	0,12	0,30 to 0,90	1,00 to 1,85	0,025	0,025	—	—	0,40 to 0,65	0,50	—
3M3T	0,12	0,40 to 1,00	1,00 to 1,80	0,025	0,025	—	—	0,40 to 0,65	0,50	0,02 to 0,30
4M3	0,12	0,30	1,50 to 2,00	0,025	0,025	—	—	0,40 to 0,65	0,50	—
4M31	0,07 to 0,12	0,50 to 0,80	1,60 to 2,10	0,025	0,025	—	—	0,40 to 0,60	0,50	—
4M3T	0,12	0,50 to 0,80	1,60 to 2,20	0,025	0,025	—	—	0,40 to 0,65	0,50	0,02 to 0,30
N1M2T	0,12	0,60 to 1,00	1,70 to 2,30	0,025	0,025	0,40 to 0,80	—	0,20 to 0,60	0,50	0,02 to 0,30
N1M3	0,12	0,20 to 0,80	1,00 to 1,80	0,025	0,025	0,30 to 0,90	—	0,40 to 0,65	0,50	—
N2M1T	0,12	0,30 to 0,80	1,10 to 1,90	0,025	0,025	0,80 to 1,60	—	0,10 to 0,45	0,50	0,02 to 0,30
N2M2T	0,05 to 0,15	0,30 to 0,90	1,00 to 1,80	0,025	0,025	0,70 to 1,20	—	0,20 to 0,60	0,50	0,02 to 0,30
N2M3	0,12	0,30	1,10 to 1,60	0,025	0,025	0,80 to 1,20	—	0,40 to 0,65	0,50	—
N2M3T	0,05 to 0,15	0,30 to 0,90	1,40 to 2,10	0,025	0,025	0,70 to 1,20	—	0,40 to 0,65	0,50	0,02 to 0,30
N2M4T	0,12	0,50 to 1,00	1,70 to 2,30	0,025	0,025	0,80 to 1,30	—	0,55 to 0,85	0,50	0,02 to 0,30
N3M2[c]	0,08	0,20 to 0,55	1,25 to 1,80	0,010	0,010	1,40 to 2,10	0,30	0,25 to 0,55	0,25	0,10
N4M2[d]	0,09	0,20 to 0,55	1,40 to 1,80	0,010	0,010	1,90 to 2,60	0,50	0,25 to 0,55	0,25	0,10
N4M3T	0,12	0,45 to 0,90	1,40 to 1,90	0,025	0,025	1,50 to 2,10	—	0,40 to 0,65	0,50	0,01 to 0,30
N4M4T	0,12	0,40 to 0,90	1,60 to 2,10	0,025	0,025	1,90 to 2,50	—	0,40 to 0,90	0,50	0,02 to 0,30
N5M3[e]	0,10	0,25 to 0,60	1,40 to 1,80	0,010	0,010	2,00 to 2,80	0,60	0,30 to 0,65	0,25	0,10
N5M3T	0,12	0,40 to 0,90	1,40 to 2,00	0,025	0,025	2,40 to 3,10	—	0,40 to 0,70	0,50	0,02 to 0,30
N7M4T	0,12	0,30 to 0,70	1,30 to 1,70	0,025	0,025	3,20 to 3,80	0,30	0,60 to 0,90	0,50	0,02 to 0,30

Table 3B (*continued*)

Symbol (ISO 16834-B)	Chemical composition % (by mass)[a,b]									
	C	Si	Mn	P	S	Ni	Cr	Mo	Cu	Ti
C1M1T	0,02 to 0,15	0,50 to 0,90	1,10 to 1,60	0,025	0,025	—	0,30 to 0,60	0,10 to 0,45	0,40	0,02 to 0,30
N3C1M4T	0,12	0,35 to 0,75	1,25 to 1,70	0,025	0,025	1,30 to 1,80	0,30 to 0,60	0,50 to 0,75	0,50	0,02 to 0,30
N4CM2T	0,12	0,20 to 0,60	1,30 to 1,80	0,025	0,025	1,50 to 2,10	0,20 to 0,50	0,30 to 0,60	0,50	0,02 to 0,30
N4CM21T	0,12	0,20 to 0,70	1,10 to 1,70	0,025	0,025	1,80 to 2,30	0,05 to 0,35	0,25 to 0,60	0,50	0,02 to 0,30
N4CM22T	0,12	0,65 to 0,95	1,90 to 2,40	0,025	0,025	2,00 to 2,30	0,10 to 0,30	0,35 to 0,55	0,50	0,02 to 0,30
N5CM3T	0,12	0,20 to 0,70	1,10 to 1,70	0,025	0,025	2,40 to 2,90	0,05 to 0,35	0,35 to 0,70	0,50	0,02 to 0,30
N5C1M3T	0,12	0,40 to 0,90	1,40 to 2,00	0,025	0,025	2,40 to 3,00	0,40 to 0,60	0,40 to 0,70	0,50	0,02 to 0,30
N6CM2T	0,12	0,30 to 0,60	1,50 to 1,80	0,025	0,025	2,80 to 3,00	0,05 to 0,30	0,25 to 0,50	0,50	0,02 to 0,30
N6C1M4	0,12	0,25	0,90 to 1,40	0,025	0,025	2,65 to 3,15	0,20 to 0,50	0,55 to 0,85	0,50	—
N6C2M2T	0,12	0,20 to 0,50	1,50 to 1,90	0,025	0,025	2,50 to 3,10	0,70 to 1,00	0,30 to 0,60	0,50	0,02 to 0,30
N6C2M4	0,12	0,40 to 0,60	1,80 to 2,00	0,025	0,025	2,80 to 3,00	1,00 to 1,20	0,50 to 0,80	0,50	0,04
N6CM3T	0,12	0,30 to 0,70	1,20 to 1,50	0,025	0,025	2,70 to 3,30	0,10 to 0,35	0,40 to 0,65	0,50	0,02 to 0,30
G[f]	Any agreed analysis not specified in this International Standard									

[a] The filler metal shall be analysed for the specific elements for which values are shown in this table. If the presence of other elements is indicated in the course of this work, the amount of these elements shall be determined to ensure that their total (excluding iron) does not exceed 0,50 % (by mass).

[b] Single values are maximum values.

[c] V 0,05 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[d] V 0,04 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[e] V 0,03 % (by mass), Zr 0,10 % (by mass), Al 0,10 % (by mass).

[f] Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter G. The chemical composition ranges are not specified and therefore it is possible that two electrodes with the same G classification are not interchangeable.

5 Mechanical tests

5A Classification by yield strength and 47 J impact energy

Tensile and impact tests shall be carried out in the as-welded condition or in the post-weld heat-treated condition using an all-weld metal test piece type 1.3, in accordance with ISO 15792-1:2000, Table 1, using 1,2 mm diameter for gas shielded electrodes, or test piece type 1.1, in accordance with ISO 15792-1:2000, using 2,4 mm diameter for tungsten inert-gas welding rods or wires, and welding conditions and PWHT condition as described in 5.1A, 5.2A and 5.3A.

5B Classification by tensile strength and 27 J impact energy

Tensile and impact tests shall be carried out in the as-welded condition or in the post-weld heat-treated condition using an all-weld metal test piece type 1.3, in accordance with ISO 15792-1:2000, Table 1, using 1,2 mm diameter for gas shielded electrodes, or using test piece type 1.1 and 2,4 mm diameter for tungsten inert-gas welding rods or wires, and welding conditions and PWHT condition as described in 5.1B, 5.2B, and 5.3B. If a 1,2 mm or 2,4 mm diameter is not manufactured, use the closest size at settings as recommended by the manufacturer.

5.1 Preheating and interpass temperatures

5.1A Classification by yield strength and 47 J impact energy

Welding of the all-weld metal test piece shall be executed in a temperature range from 120 °C to 180 °C, with the exception of the first layer in the test piece, which may be welded without preheating.

The interpass temperature shall be measured using temperature-indicator crayons, surface thermometers or thermocouples in accordance with ISO 13916.

5.1B Classification by tensile strength and 27 J impact energy

Preheating and interpass temperatures shall be selected for the appropriate weld metal type from Table 4B. The interpass temperature shall be measured using temperature-indicator crayons, surface thermometers or thermocouples in accordance with ISO 13916.

Welding shall continue until the assembly has reached the maximum interpass temperature given in Table 4B. If, after any pass, this interpass temperature is exceeded, the test piece shall be cooled in air to a temperature within that range. If below interpass temperature, reheat into the interpass range.

Table 4B — Preheating and interpass temperatures

Symbol	Preheat temperature for 1st pass only °C	Preheat and interpass temperature for all other passes °C
GG and WG	As agreed between purchaser and supplier	
Other symbols except for GG and WG	100 to 165	150 ± 15

5.2 Welding conditions and pass sequence

5.2A Classification by yield strength and 47 J impact energy

The welding conditions shall be as indicated in Table 5A and the pass sequence as given in Table 6A. The direction of welding to complete a layer consisting of two passes shall not vary, but the direction of welding of layers shall be alternated.

Table 5A — Welding conditions
(Classification by yield strength and 47 J impact energy)

Process	Diameter mm	Welding current A	Welding voltage V	Contact tube distance mm	Travel speed mm/min
G	1,2	280 ± 10	[a]	20 ± 3	450 ± 50
W	2,4	200 ± 20	[b]	—	150 ± 15

[a] The welding voltage depends on the choice of shielding gas.

[b] It is not possible to set the voltage on a tungsten–inert gas (TIG) equipment.

Table 6A — Pass sequence
(Classification by yield strength and 47 J impact energy)

Process	Diameter mm	Passes per layer	Number of layers
G	1,2	2[a]	6 to 10
W	2,4	2[b]	8 to 11

[a] The top layer can be completed with three passes.

[b] The top layer can be completed with three or four passes.

5.2B Classification by tensile strength and 27 J impact energy

The welding conditions shall be as indicated in Table 5B and the pass sequence as given in Table 6B. The direction of welding to complete a layer consisting of two passes shall not vary, but the direction of welding of layers shall be alternated.

Table 5B — Welding conditions
(Classification by tensile strength and 27 J impact energy)

Process	Diameter mm	Welding current A	Welding voltage V	Contact tube distance mm	Travel speed mm/min
G	1,2	290 ± 30	[a]	20 ± 3	330 ± 60
W	2,4	220 ± 30	[b]	—	100 ± 30

[a] The welding voltage depends on the choice of shielding gas.

[b] It is not possible to set the voltage on a TIG equipment.

Table 6B — Pass sequence
(Classification by tensile strength and 27 J impact energy)

Process	Diameter mm	Passes per layer	Number of layers
G	1,2	2 or 3	6 to 10
W	2,4	2[a]	8 to 11

[a] The top layer can be completed with three or four passes.

5.3 Post-weld heat-treated condition

5.3A Classification by yield strength and 47 J impact energy

Test pieces made with wire electrodes, wires, rods and deposits classified in the PWHT condition shall be heat-treated at 560 °C to 600 °C for 60 min. The test piece shall be left in the furnace to cool to 300 °C.

5.3B Classification by tensile strength and 27 J impact energy

Test pieces made with wire electrodes, wires, rods and deposits classified in the PWHT condition shall be heat-treated at 610 °C ± 25 °C for 60 min to 75 min. The furnace shall be at a temperature not higher than 300 °C when the test piece is placed in it. The heating rate, from that point to the 610 °C ± 25 °C holding temperature, shall not exceed 220 °C/h. When the holding time has been completed, the assembly shall be allowed to cool in the furnace to a temperature below 300 °C at a rate not exceeding 195 °C/h. The assembly may be removed from the furnace at any temperature below 300 °C, and allowed to cool in still air to room temperature.

6 Chemical analysis

Chemical analysis shall be performed on specimens of the wire electrode, wire or rod. Any analytical technique may be used, but in case of dispute reference shall be made to established published methods.

6A Classification by yield strength and 47 J impact energy

The results of chemical analysis shall fulfil the requirements given in Table 3A for the classification under test.

6B Classification by tensile strength and 27 J impact energy

The results of chemical analysis shall fulfil the requirements given in Table 3B for the classification under test

7 Rounding procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subject to ISO 80000-1:2009, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this International Standard, the measured values shall be converted to the units of this International Standard before rounding. If an arithmetic average value is to be compared to the requirements of this International Standard, rounding shall be done only after calculating the arithmetic average. If the test method cited in Clause 2 contains instructions for rounding that conflict with the instructions of this International Standard, the rounding requirements of the test method standard shall apply. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

8 Retest

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original test piece or from a new test piece. For chemical analysis, retests need only be for those specific elements that failed to meet their test requirement. If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test piece or test specimen(s), or in conducting the tests, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirement. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9 Technical delivery conditions

Technical delivery conditions shall meet the requirements in ISO 544 and ISO 14344.